N91-25997

Dust Particles from Comets and Asteroids Collected at the Earth's Orbit: Parent-Daughter Relationships

A. A. Jackson
Lockheed Engineering and Sciences Company, Houston Texas

H. A. Zook National Aeronautics and Space Administration, Houston, Texas

The relative contributions of comets and asteroids to the reservoir of dust in the interplanetary medium is not well known. There are direct observations of dust released from comets and there is evidence to associate the IRAS dust bands with possible collisions of Asteroids in the main belt (1). A means towards identifying the parent sources has been proposed in the establishment of a dust collector on the Freedom Space Station, the CDCF (Cosmic Dust Collection Facility) Horz (2). The purpose of such a facility would be to collect not only cosmic dust particles intact but also the state vectors they have as they arrive at the detector. The idea being that one may combine analytical laboratory analysis of the physics and chemistry of the captured particles with orbital data in order to identify comet and asteroid parent bodies.

It is possible to use the collected orbits of the dust to connect with its source in two ways. One is to consider the long time orbit evolution of the dust under Poynting-Robertson drag. The other is to look at the prompt orbit change of dust from comets onto trajectories that intersects the earth's orbit.

The orbital motion of dust when radiation forces alone are acting is well understood, Burns, et. al. (3) When gravitational forces due to the planets are included the motion can become quite complex, Gonczi, Froeschle and Froeschle (4), Gustafson and Misconi (4) Jackson and Zook (5). In order to characterize the orbits of dust particles evolved over a long period of time a study of its orbital evolution was undertaken. We have considered various parameters associated with these dust orbits as they cross the Earth's orbit to see if one may in a general way discriminate between particles evolved from comets and asteroids.

In the study we considered the dust particles as ideal black bodies,of density of 1 gm/cc, and spherical with radii between 10 to 100 microns. Particles of this size are effected by radiation forces, photon pressure and Poynting-Robertson drag. Account was also taken of solar wind drag which amounts to about 30 percent of the Poynting-Robertson drag. For particles of these sizes radial solar wind pressure and Lorentz forces are negligible. The gravitational forces due to the planets are included, with the planets propagated in two body Keplerian orbits only. Our method was to calculate explicitly by a numerical procedure the orbits of dust particles after they left their parent bodies.

In general dust from comets and asteroids follow complicated orbital evolutional histories as they decay into the sun. Scatterings ,exterior and interior mean motion resonances traps with the planets occur. It appears , however, that as the particles pass the earth's orbit asteroidal grains and cometary grains can be differentiated on the basis or their measured orbital eccentricities even after much planetary perturbation. Broad parent-daughter associations can be made on this basis from measurement of their trajectories intercepted in earth orbit.

Secondly for comets with perihelia close to the earth dust ejecta may have their orbital elements altered is such a way that their ascending or descending node will be promptly at the earth's orbit. Interception of these particles could lead to a clear cut identification of the cometary source body. It can also be shown using a discriminate criterion this association can retain identity over long periods of time.

REFERENCES:Dermot,S.F.,Nicholson,P.D.,and Houck,J.R.,1984,Nature,312,505-509. (2)Horz, F. (1190) NASA TM - 102160. (3)Burns, J.A.,Lamay,P.L., and Soter,S.(1979),Icarus,40,1-48. (4) Gonczi,R.,Froeschle,Ch.and Froeschle,Cl.,Icarus,51,1982, 633-654. (5)Gustafson, B. and Misconi, N., (1986),Icarus,66,280-287. (6) Jackson, A. and Zook, H., Nature,337,629-631.